# ECE 345 / ME 380: Introduction to Control Systems
# Collaborative Quiz #1 Grading Sheet

Dr. Oishi

September 10, 2020

This quiz is open-note and open-book. Calculators and Matlab are allowed. No partial credit will be awarded. For each of the questions, clearly write the correct answer.

## In-Class Questions

1. (d) $A_P = \begin{bmatrix} 0 & 1 \\ -\frac{mgl}{I} & 0 \end{bmatrix}$, $B_P = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C_P = \begin{bmatrix} -\frac{1}{I} & 0 \end{bmatrix}$, $D_P = 0$
2. (a) $s^2 + mgl/I$
3. (b) $G(s) = H(s)$, because a transfer function can be represented by many different state-space models.
4. (d) The input indirectly affects the generated torque $\tau(t)$ and the flywheel angular velocity $\dot{\theta}(t)$.
5. We would require a lower inertia to allow the flywheel to spin up at higher acceleration, z($t_{hop}$) is inversely proportional to the flywheel inertia.

please see next page for equations

## Statement of Effort

By providing my name below, I pledge that I have written this quiz as per the indicated instructions, and fully participated in the group.

| | |
|---|---|
| Nathan Burt | burtn@unm.edu |
| Name | Email `@unm.edu` |
| Noah Jackson | njackson18@unm.edu |
| Name | Email `@unm.edu` |
| David Kirby | davidkirby@unm.edu |
| Name | Email `@unm.edu` |

$$I s^2 \theta(s) = -mgl\,\theta(s) - \tau(s)$$
$$I s^2 \theta(s) + mgl\,\theta(s) = -\tau(s)$$
$$\theta(s)\left[I s^2 + mgl\right] = -\tau(s)$$

$$G(s) = \frac{\theta(s)}{\tau(s)} = -\frac{1}{I s^2 + mgl}$$

$$= -\frac{\frac{1}{I}}{s^2 + \frac{mgl}{I}}$$

$$H(s) = C(sI - A)^{-1}B + D$$

$$= \begin{bmatrix} -\frac{1}{I} & 0 \end{bmatrix}\begin{bmatrix} s & -1 \\ \frac{mgl}{I} & s \end{bmatrix}^{-1}\begin{bmatrix} 0 \\ 1 \end{bmatrix} + \underline{0}$$

C B D

$$= \begin{bmatrix} -\frac{1}{I} & 0 \end{bmatrix} \frac{1}{s^2 + \frac{mgl}{I}} \begin{bmatrix} s & 1 \\ -\frac{mgl}{I} & s \end{bmatrix}\begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -\frac{1}{I} & 0 \end{bmatrix} \frac{1}{s^2 + \frac{mgl}{I}} \begin{bmatrix} (s)(0) + (1)(1) \\ (-\frac{mgl}{I})(0) + s \end{bmatrix}$$

$$= \begin{bmatrix} -\frac{1}{I} & 0 \end{bmatrix} \frac{1}{s^2 + \frac{mgl}{I}} \begin{bmatrix} 1 \\ s \end{bmatrix} = -\frac{1}{I}\left(\frac{1}{s^2 + \frac{mgl}{I}}\right)$$

$$G(s) = H(s)$$